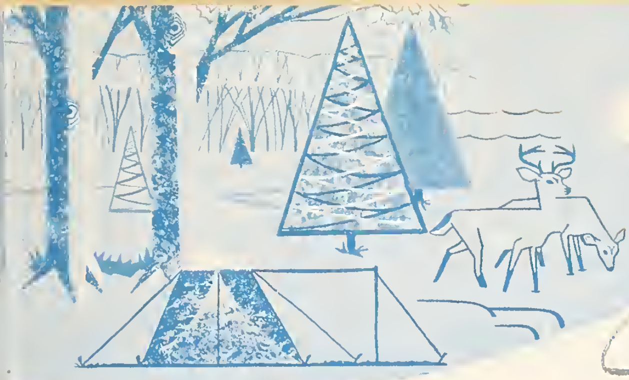

U. S. FOREST SERVICE

RESEARCH NOTE LS-29

LAKE STATES FOREST EXPERIMENT STATION • U. S. DEPARTMENT OF AGRICULTURE

Soil Moisture Trends in Thinned Red Pine Stands in Northern Minnesota

The forest manager or silviculturist generally manages a forest stand for timber production. At the same time, knowingly or unknowingly, he is also managing the soil moisture supply under the forest; management practices that affect the composition and density levels of forest stands can also affect the depletion and recharge of soil moisture. In turn, this soil moisture supply can affect the growth of a forest stand and the recharge of ground water tables, lakes, and streams.

Although soil moisture conditions under forest stands have received considerable attention in other regions, little information is available to forest land managers about northern Minnesota conditions. This paper reports on one phase of an overall study of soil moisture under forest stands in north-central Minnesota.[1] Another aspect of the study is reported in Research Note LS-30.

Soil moisture plots were established on the Cutfoot Experimental Forest, 35 miles northwest of Grand Rapids, Minn., in three density levels of red pine — 140, 100, and 60 square feet of basal area per acre. Established previously to determine growth response to various thinning treatments, these 5-acre compartments provided an opportunity to determine the interrelations between density level and soil water.

The soils are loamy outwash sands. They consist primarily of medium to coarse sand throughout the profile with discontinuous 2- to 6-inch clay lenses at depths of 6 to 10 feet.

Samples were obtained on eight dates throughout the 1957 growing season, and on three dates in 1958 — spring, midsummer, and at the end of the summer growing season. Gravimetric soil samples were taken at depths of 0-1, 1-2, 2-3, 3-5, and 5-7 feet at five randomly selected points in each plot on each sampling date.

Soil moisture content was determined on an oven-dry weight basis, then corrected for the average weight of stones 2 mm. and greater in diameter. Bulk density for each sampling horizon on each plot was determined from undisturbed soil cores and used to convert soil moisture to a volume basis. Field moisture content in early spring, shortly after snowmelt, was used as an estimate of field capacity. This corresponded very closely to the moisture content at .05-atmosphere tension. The amount of water in the soil at any time in excess of the estimated wilting point (15-atmosphere tension) was expressed as available water.

Soil moisture content in all density levels was high in early May 1957, the beginning of the growing season (fig. 1). Early depletion was rapid during May when rainfall was only 60 percent of normal. However, excessive rains in June (nearly 2½ times the long-term average) recharged the entire profile. Then, despite midsummer rains, a general depletion took place until late August, the end of the growing

[1] *Acknowledgment is due Dr. J. H. Stoeckeler, Soil Scientist at the Lake States Station, who planned the initial study and selected sampling sites.*

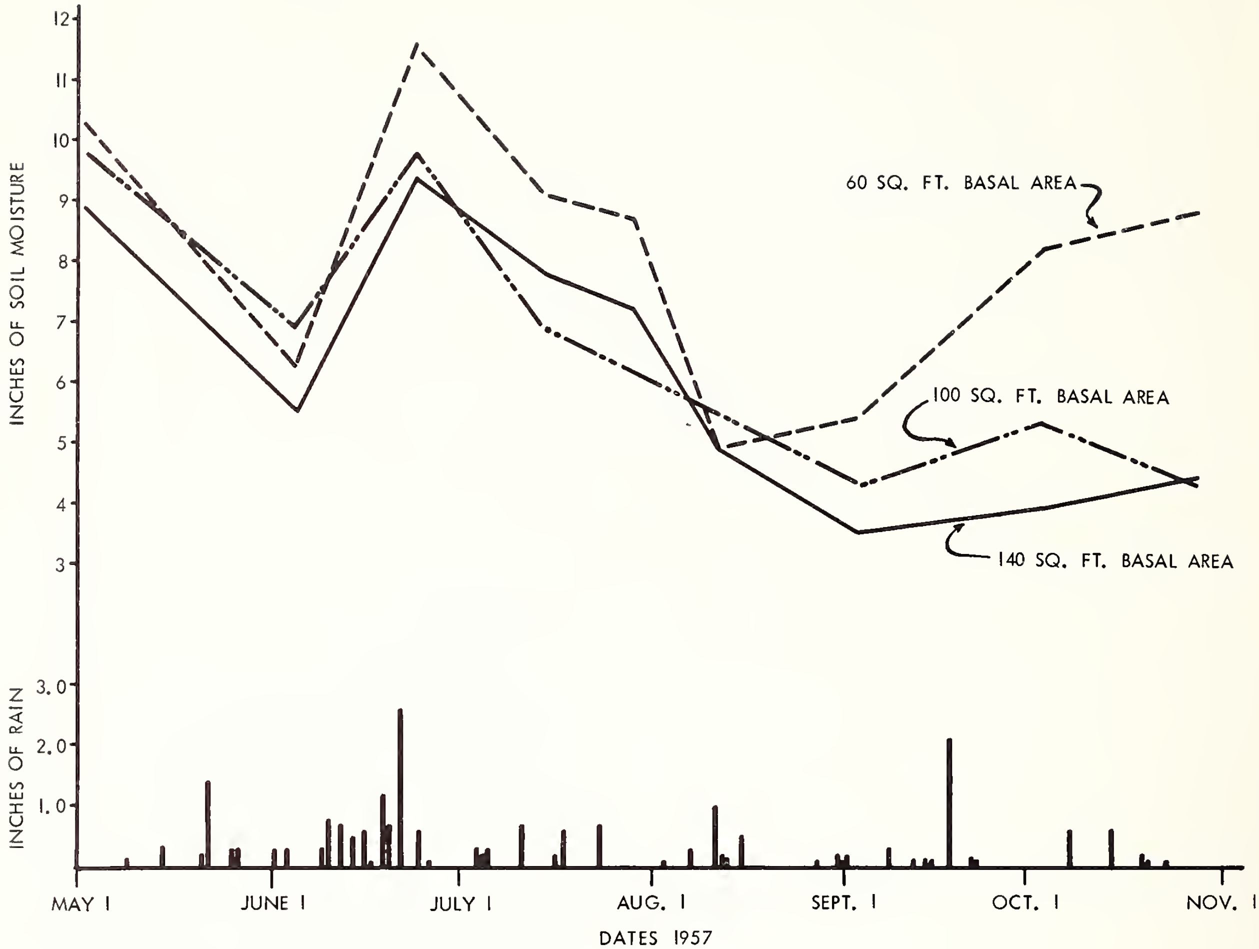

FIGURE 1. — Available soil moisture under three density levels of red pine, 1957.

season. During these latter 2 months, precipitation was 83 and 69 percent of the long-term average.

A comparison of the two extreme density levels indicates a trend of slightly less available moisture under the higher density stand. The difference was probably due in part to greater interception of precipitation as well as increased moisture use by the more densely stocked stand. This agrees with other findings in the Lake States.[2] [3]

[2] *Della-Bianca, Lino, and Dils, Robert E. Some effects of stand density in a red pine plantation on soil moisture, soil temperature, and radial growth. Jour. Forestry 58: 373-377. 1960.*

[3] *Haberland, F. P., and Wilde, S. A. Influence of thinning of red pine plantation on soil. Ecology 42: 584-586. 1961.*

Soil moisture loss, or use, followed the same depletion trends in all density levels. Within the soil profile, withdrawals took place throughout each horizon down to 7 feet. Examination of several soil pits revealed that some red pine roots do extend that deep, although most roots are concentrated in the upper 0- to 3-foot horizon. Of the total water lost in the 7-foot profile of each density level, approximately 60 percent occurred from the upper 3 feet (fig. 2). However, depletion between density levels was similar.

The soils dried gradually at all depths during the 1957 growing season, but moisture contents were not depleted to the theoretical wilt-

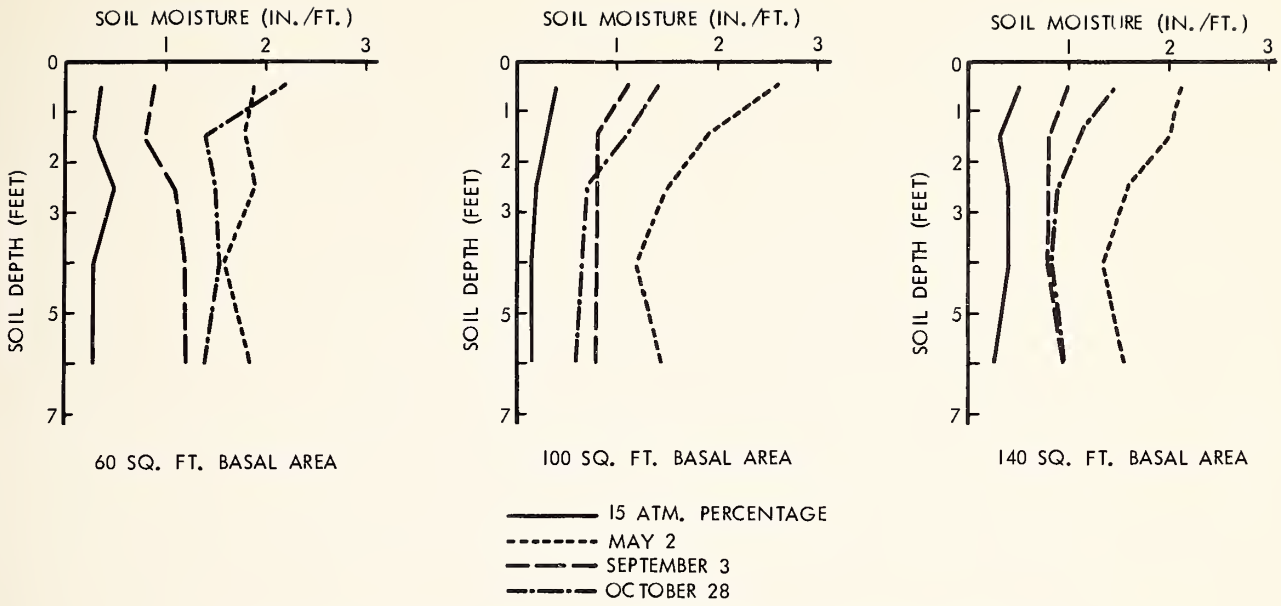

FIGURE 2. — Soil moisture depletion curves for three red pine density levels, 1957.

ing point (15-atmosphere moisture percentage) on any of the dates sampled. Moisture recharge started from the surface of the profile in early September (fig. 2). The lower density levels were recharged first. By late October, soil moisture recharge had reached the 7-foot level in the lowest density level of red pine and the 4-foot level in the densest stand.

When soil moisture values in the autumn were subtracted from the early spring moisture content on May 2, 1957 (approximate field capacity), fall moisture deficits were consistently less under the lowest density level:

Square feet of basal area	*Deficit (inches of water) on:* Nov. 1, 1956	Sept. 3, 1957	Sept. 10, 1958
140	6.6	5.4	5.8
100	5.2	5.5	4.8
60	4.8	4.9	2.6

Thus, less winter snowmelt water would be required to recharge the soil mantle under the plot with 60 square feet of basal area. Excess water would be available for ground water recharge and streamflow. Late fall and overwinter precipitation was required to fully recharge soil moisture in all density levels. The value of snow to annual recharge of soil moisture and ground water is evident.

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